

CLAIMS

What is claimed is:

5 1. A method of projecting an image with display-condition compensation, the method, comprising:

projecting a principal image onto a principal area of a surface;

projecting an intended calibration image onto a calibration area of the surface when the principal image is not projected onto the calibration area;

10 receiving the calibration image displayed on the surface;

comparing the received calibration image to the intended calibration image to determine an observed difference; and

modifying projection of the principal image based on the observed difference.

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2. The method of claim 1, where comparing the received calibration image to the intended calibration image includes determining a color characteristic of the received calibration image and comparing it to a corresponding color characteristic of the intended calibration image.

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3. The method of claim 1, where projecting a principal image includes projecting a principal image without a portion of the principal image corresponding to the calibration area, and projecting a calibration image includes projecting the calibration image onto the calibration area while 25 projecting the principal image without the portion.

4. The method of claim 1, where comparing the received calibration image to the intended calibration image includes comparing an intended calibration image color characteristic to a received calibration image color 30 characteristic corresponding to at least a portion of the calibration area.

5. The method of claim 1, further comprising:
 - segmenting the intended calibration image into a plurality of subunits;
 - and
 - segmenting the received calibration image into a corresponding plurality
- 5 of subunits;
 - where comparing the received calibration image to the intended calibration image includes determining a color characteristic for each intended calibration image subunit, determining a color characteristic for each received calibration image subunit; and
- 10 comparing the intended calibration color characteristic to the received calibration image color characteristic for at least one subunit.

6. The method of claim 1, where modifying the projected principal image includes determining a correction based on the observed difference.

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7. The method of claim 6, where modifying the projected principal image includes applying the correction to principal image data.

8. The method of claim 6, where modifying the projected principal image includes applying the correction to commands received by a light engine to create the projected principal image.

9. The method of claim 6, where modifying the projected principal image includes applying the correction to one or more operating parameters of a light engine used to create the projected principal image.

10. The method of claim 1, where projecting the principal image includes projecting the principal image from at least a first light source, and projecting an intended calibration image includes projecting the intended calibration image from at least a second light source.

11. The method of claim 1, further comprising, prior to modifying the principal image, modifying the calibration image, projecting the modified intended calibration image onto the calibration area of the surface when the principal image is not projected onto the calibration area, receiving the modified 5 calibration image displayed on the surface, and comparing the received modified calibration image to the modified calibration image to determine an observed difference.

12. The method of claim 1, where comparing the received calibration 10 image to the intended calibration image includes:

determining a color characteristic for at least a subunit of the received calibration image; and

determining a difference between the determined color characteristic and an intended color characteristic of at least a subunit of the intended calibration 15 image.

13. The method of claim 12, where modifying the projection of the principal image includes determining a correction configured to reduce the determined difference between the intended and determined color 20 characteristic, and modifying projection of the principal image based on the determined correction.

14. The method of claim 13, where modifying projection of the principal image includes modifying principal image data.

25 15. The method of claim 13, where modifying projection of the principal image includes modifying one or more light engine commands derived from principal image data.

30 16. The method of claim 13, where modifying projection of the principal image includes modifying one or more operating parameters of a light engine.

17. The method of claim 12, where determining a color characteristic, and determining a difference between the determined color characteristic and an intended color characteristic is repeated for each subunit of the intended calibration image and corresponding subunit of the displayed calibration image.

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18. The method of claim 12, where a color characteristic includes one or more of an average red intensity, an average blue intensity, an average green intensity, average color, chromaticity, color temperature and luminance.

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19. The method of claim 12, further comprising capturing the displayed calibration image using at least one of a color-sensing device, a colorimeter, a luminance meter, a color temperature meter, and a camera.

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20. A display device comprising:

a light engine apparatus configured to project a principal image and a calibration image onto a surface, where at least a portion of the calibration image has an intended first color characteristic;

an optical unit configured to receive a reflection of the projected calibration image; and

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a processor configured to

direct projection of the calibration image onto a calibration area of the surface when the principal image is not projected onto the calibration area;

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compare the received calibration image to the calibration image to determine an observed difference; and

modify projection of the principal image based on the observed difference.

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21. The display device of claim 20, where the optical unit is at least one of a color-sensing device, a colorimeter, a luminance meter, a color temperature meter and a camera.

22. The display device of claim 20, further including memory connected to the processor, where the memory is configured to store the intended first color characteristic.

5 23. The display device of claim 20, where the light engine apparatus includes a light engine configured to project the principal image and a calibration light unit configured to project the calibration image.

10 24. The display device of claim 23, where the calibration light unit projects the calibration image along at least a portion of a light path along which the light engine projects the principal image.

15 25. The display device of claim 24, further comprising an optical device configured to insert the calibration image into the light path along which the principal image is projected.

26. The display device of claim 25, where the optical unit receives the displayed calibration image along at least a portion of the light path along which the calibration light unit projects the calibration image.

20 27. The display device of claim 23, further comprising a first housing containing the light engine, and a second housing containing the optical unit.

25 28. The display device of claim 27, where the second housing is freely movable relative to the first housing.

30 29. The display device of claim 28, further comprising an output device mounted on the second housing, the output device coupled to the optical unit for outputting a signal representative of the received displayed calibration image.

30. The display device of claim 29, where the output device and optical unit are configured to output a signal representative of a received first color characteristic.

5 31. The display device of claim 29, further comprising an input device mounted on the first housing, the input device coupled to the processor for inputting the signal representative of the received displayed calibration image.

10 32. The display device of claim 23, where the processor is further configured to:

determine an actual first color characteristic of at least a portion of the received calibration image;

15 calculate a difference between intended and actual first color characteristics for corresponding portions of the calibration image and the received calibration image;

calculate a correction based on the calculated difference between the intended and actual first color characteristics; and

modify projection of at least one of the principal image and the calibration image based on the correction.

20 33. The display device of claim 32, where the light engine is configured to project the principal image onto a principal area of the surface including at least a portion of the calibration area, and the processor is further configured to direct the light engine not to project the principal image onto at 25 least the calibration area of the surface while the calibration image is being projected.

34. The display device of claim 33, further comprising an input device coupled to the processor and configured to be manually actuated, the processor 30 being configured to initiate projection of a calibration image when the input device is actuated.

35. The display device of claim 32, where the processor is further configured to terminate projection of the principal image on at least the calibration area of the surface while projecting the calibration image.

5 36. The display device of claim 32, where the color characteristic is at least one of an average color, a chromaticity, a color temperature and a luminance.

10 37. The display device of claim 36, where the average color includes one or more of an average red intensity, an average blue intensity and an average green intensity.

15 38. A calibration unit for use with a projector configured to project a principal image onto a surface and having selectable color compensation, the calibration unit comprising:

a calibration light unit configured to project an intended calibration image onto the surface;

an optical unit configured to receive the reflection of the projected calibration image; and

20 an output device coupled to the optical unit for outputting a signal corresponding to the received calibration image.

39. A display device comprising:

means for projecting a principal image onto a surface;

25 means for projecting a calibration image onto a calibration area of the surface when the principal image is not projected onto the calibration area;

means for receiving the calibration image displayed on the surface;

means for comparing the received calibration image to the calibration image projected to determine an observed difference; and

30 means for modifying projection of the principal image based on the observed difference.

40. A storage medium readable by a processor, having embodied therein a program of commands executable by the processor to:

- project a principal image onto a surface;
- project a calibration image onto a calibration area of the surface when the 5 principal image is not projected onto the calibration area;
- receive the calibration image displayed on the surface;
- compare the calibration image received to the calibration image projected to determine an observed difference; and
- modify projection of the principal image based on the observed 10 difference.

41. An electronic device comprising:

- a light engine apparatus configured to project a principal image and a calibration image onto a surface, where a portion of the calibration image has 15 an intended first color characteristic; and
- an optical unit configured to receive the displayed image of the projected calibration image;
- the light engine apparatus and the optical unit cooperating to:
 - project the calibration image onto a calibration area of the surface 20 when the principal image is not projected onto the calibration area;
 - determine an actual color characteristic for a portion of the displayed calibration image corresponding to the portion of the calibration image;
 - calculate a difference between the intended and actual color 25 characteristics; and
 - modify projection of the principal image based on the calculated difference.